

## THE WEATHER AND CIRCULATION OF MARCH 1970

### Many Wet and Cool Areas Associated With Retrogression and an Increase in Blocking

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#### 1. MEAN CIRCULATION

Long-wave retrogression over the United States from February to March had a marked effect on average weather in the United States, particularly in the West. By mid-March, the strong ridge that had maintained mild dry weather in the West during January and February had retrograded to the eastern Pacific, leading to formation of a new trough in the Southern Plains (fig. 1). This behavior of the circulation took place as wavelengths became adjusted to stronger high-latitude blocking and slower midlatitude westerlies. Evidence that blocking increased is provided by figure 2 that shows substantial rises of height anomaly from February to March extending from eastern Canada to Great Britain and falls from the Western States to the Mediterranean. Height rises in the Atlantic indicate the continuation of anticyclogenesis that occurred from January to February (Stark 1970) and culminated in March in a strong blocking High with positive departures of about 170 m (fig. 3). In a pattern characteristic of blocking, one branch of the mean 700-mb westerlies went northward around this High while another branch took a southern route across the Atlantic (fig. 4). A number of surface cyclones also followed the southern track. It is of some interest that three of these storms crossed a 5° latitude-longitude square near the Canary Islands where surface Lows have been notably rare. While a recent count is not available, only seven such passages were recorded in March from 1899 through 1938 (Klein 1957). Another effect of blocking was to reduce the average westerly wind speed from 11.4 m sec<sup>-1</sup> in February to 7.3 m sec<sup>-1</sup> in March along the latitude band 35°–55° from 0° westward to longitude 180°. Thus, the zonal index returned to the below-normal values that had prevailed since October, except in February.

Over Eurasia, magnitudes of central anomalies in the two major high-latitude systems remained nearly constant, but amplification occurred at middle latitudes. The European trough intensified across the Mediterranean Sea, and the Asian ridge extended northeastward to the Arctic High that nearly lost its identity as a cutoff system. These changes did little to reduce the dominance of blocking as the major characteristic of the mean circulation over Asia (figs. 3 and 4).

In the Pacific, the Aleutian Low was somewhat less intense, but its influence continued to encompass a wide area (fig. 1). Average wind speeds were as much as 14 m

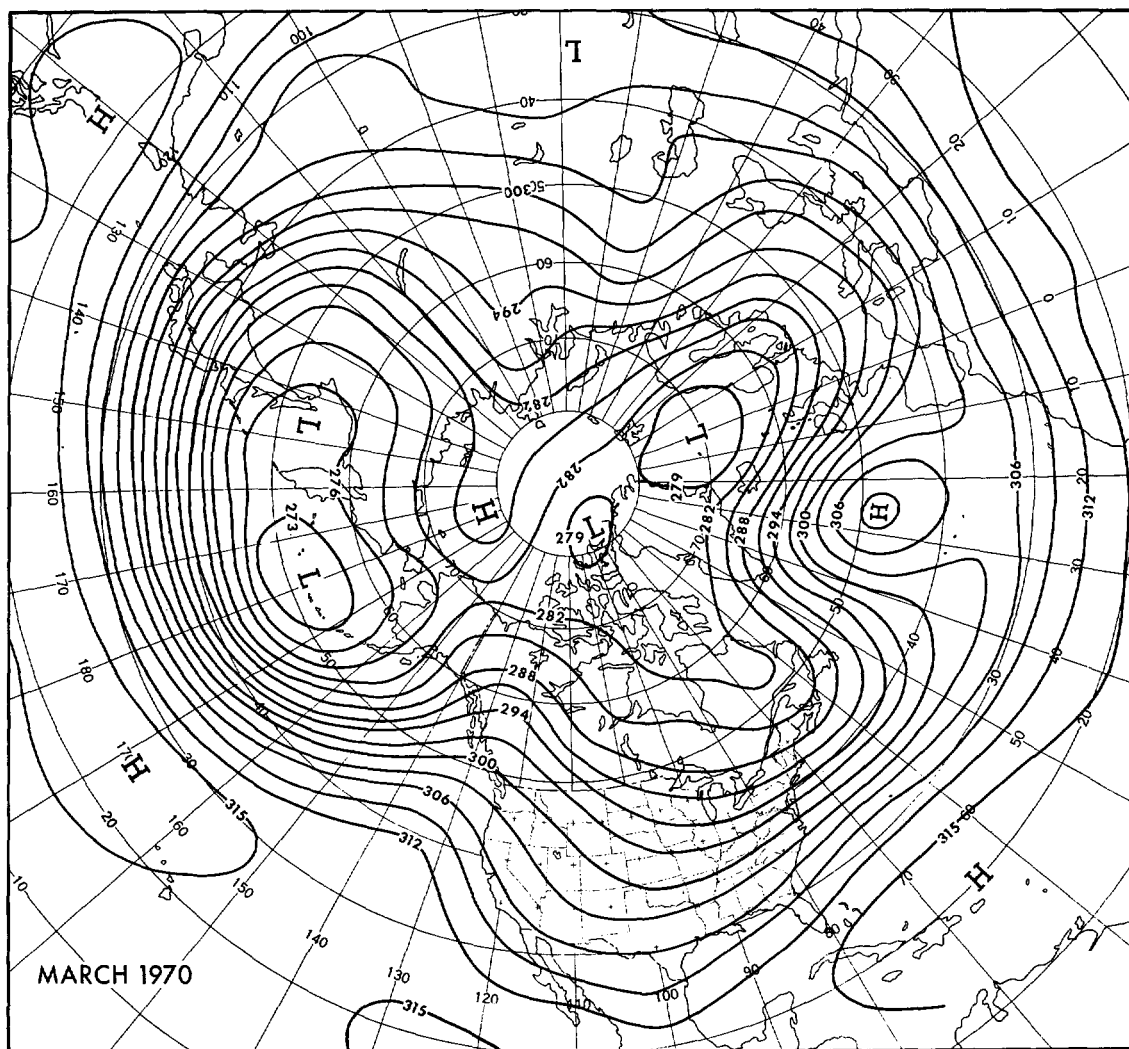
sec<sup>-1</sup> faster than normal in the mid-Pacific along the jet maximum that was located not far from the March normal (fig. 4). Sea-level pressure anomalies (not shown) were as much as -17 mb near the Aleutians and distributed in a pattern very similar to the composite sea-level anomaly chart for light rain in Hawaii (Solot 1950). This relationship was apparent in March 1970, with very light amounts at several Hawaiian stations including Honolulu with less than 3 percent of normal March rainfall. Over Alaska, stronger than normal southerly flow from the deep Aleutian Low contributed to generally higher than normal temperatures. Retrogression in this part of the hemisphere is indicated by height rises in the eastern Pacific and falls in the western Pacific (fig. 2). Maximum rises took place where February's low-latitude trough in the eastern Pacific was nearly eliminated.

#### 2. MONTHLY WEATHER

Average temperatures were below normal in most states as the circulation became more cyclonic in the United States and less cyclonic in Canada (fig. 5). Mean westerlies and associated storm tracks were south of normal for March, which encouraged Arctic outbreaks and abnormal snowfall in Southern States. Temperature anomalies were reduced by one or more classes from February to March almost everywhere west of the Mississippi River. Over the country as a whole, 60 percent of the standard network of stations were a class or more lower, 26 percent were unchanged, and 14 percent were higher. The greatest change of both temperature and height anomaly occurred over the northern and central Rockies and adjacent areas of the Great Plains.

Some temperature highlights included lowest temperatures for so late in the season at West Palm Beach, Fla. (40° on the 15th), Concordia, Kans. (3° on the 28th), and Concord, N.H. (5° on the 30th). This was the 11th consecutive month with temperatures below normal at Erie, Pa., the 10th such month at Columbus, Ohio, and the eighth at Nashville, Tenn. It was colder at many western cities in March than in February. The monthly temperature fell 5.8° at Cheyenne, Wyo., where there is a normal rise of 5.1°F, and fell 3.4° at Flagstaff, Ariz., with an expected rise of 6.0°F.

Highest percentages of normal precipitation were generally consistent with a southward track of synoptic scale cyclones, except where topographical features inter-



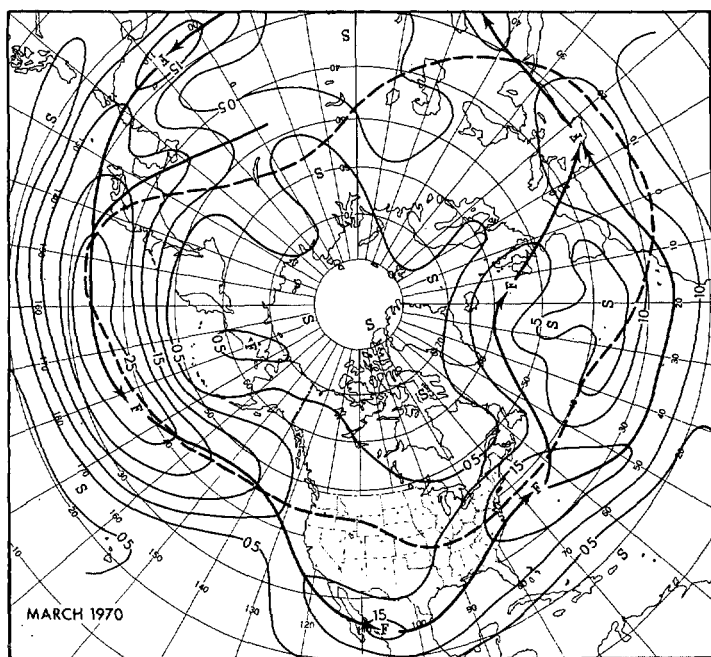


FIGURE 4.—Mean 700-mb isotachs (meters per second) for March 1970. Heavy arrows indicate axes of maximum wind speed, dashed line the normal.

ferred (fig. 6). More than four times the normal precipitation fell in parts of Arizona; Flagstaff with 6.75 in. and Yuma with 0.82 in. had record totals for March. At Flagstaff, the precipitation was frozen, resulting in a record snowfall of 67.3 in. Record snowfall was also reported at Lander, Wyo., 40.3 in., and Springfield, Mo., 23.9 in. At Dodge City, Kans., snowfall came within 0.3 in. of the record amount; at Sheridan, Wyo., and Pueblo, Colo., it was the third snowiest March. Heavy precipitation east of the Divide was encouraged by anomalous easterly flow that was directed toward higher terrain and frequent fresh outbreaks of Arctic air. Rainfall was very heavy in the Southeast, mostly from developing storms that crossed the region from the Gulf of Mexico. In Florida, record March totals were measured at Fort Myers, 18.58 in., West Palm Beach, 11.95 in., and Jacksonville, 9.98 in. Parts of the Northern Plains received more than usual March precipitation, largely from two storms. Over much of the Far West, proximity of the mean ridge and a downslope component of anomalous 700-mb flow accounted for subnormal precipitation. Other areas were bypassed by storms and reported deficient amounts, including parts of the Great Plains, the Great Lakes Region, and the Appalachians.

### 3. WEATHER BY WEEKS

During the week of March 2–8, one branch of the westerlies was near the Canadian border of the United States, while a weaker branch stayed near the southern border (figs. 7A and 7B). Temperatures averaged above

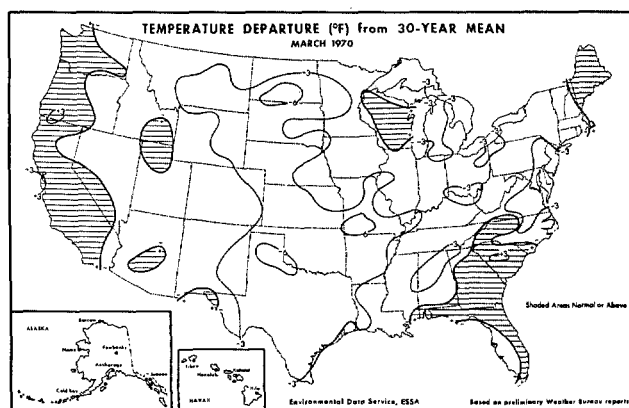


FIGURE 5.—Departure from normal of average surface temperature ( $^{\circ}$ F) for March 1970 (from Environmental Data Service 1970).

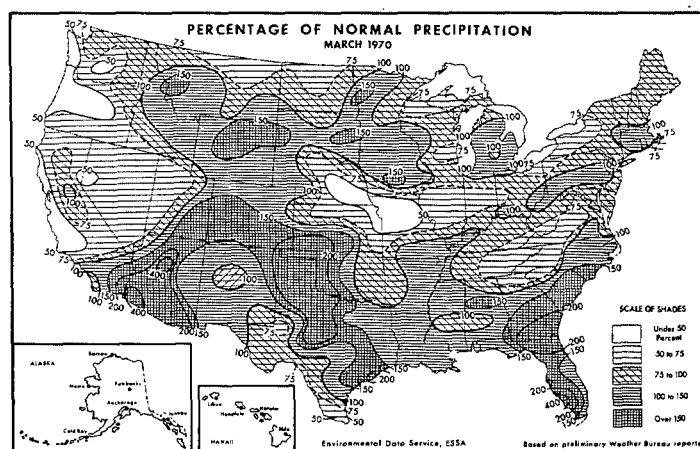


FIGURE 6.—Percentage of normal precipitation for March 1970 (from Environmental Data Service 1970).

normal over the Nation except for California and a strip from eastern Washington to Lake Superior (fig. 7C). This was the eighth consecutive week that temperatures were above normal in the West. It also marked the first break in several weeks of subnormal temperatures east of the Divide and was the warmest week in several months at many eastern cities. Precipitation (fig. 7D) was mostly associated with two storms which followed very different paths. The first formed over the central Rockies, crossed the Central Plains causing a few tornadoes in Kansas and heavy rains in the upper Mississippi Valley, and dissipated over New England. The second storm caused large quantities of precipitation from Oregon to Arizona and tornadoes with heavy rain in the Gulf Coast States.

The week of March 9–15 (fig. 8) had a much more amplified circulation over North America with a ridge across the Western States connected to a blocking High in Canada. In response to northerly anomalous flow, temperatures were much colder east of the Divide, with subzero minimums on 2 days in parts of the Northern Plains. At Columbia, Mo., much above-normal temperatures the previous week were replaced by much below.

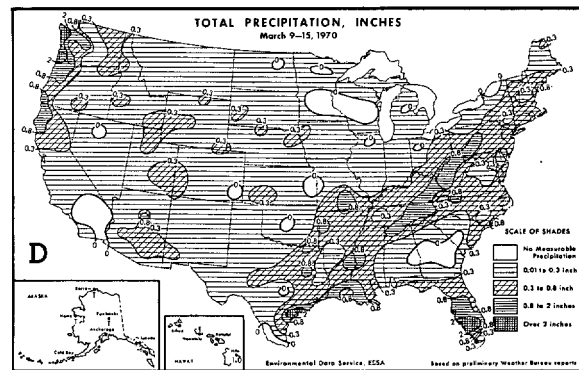
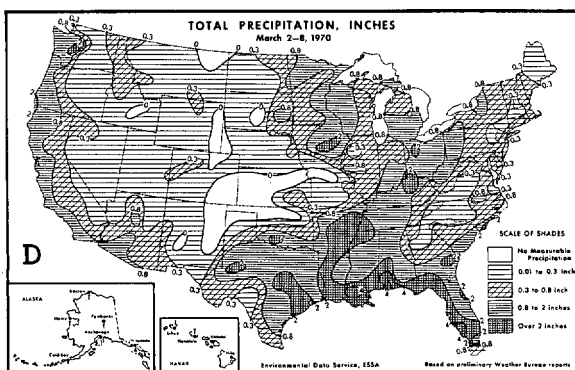
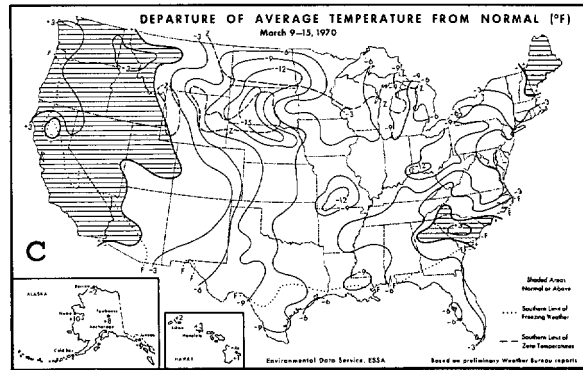
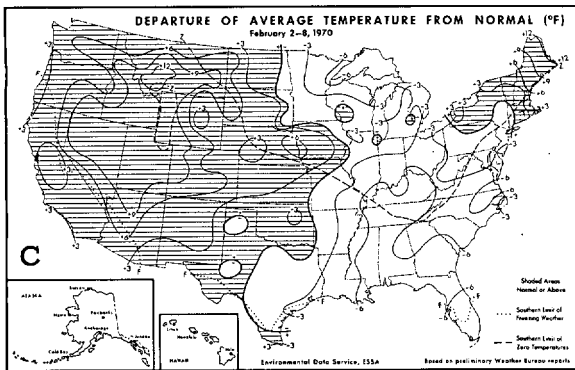
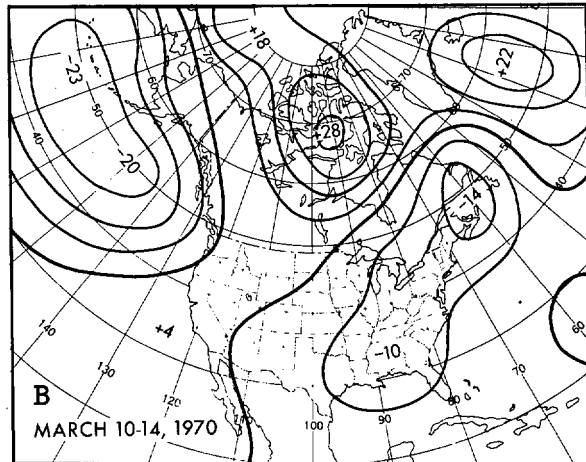
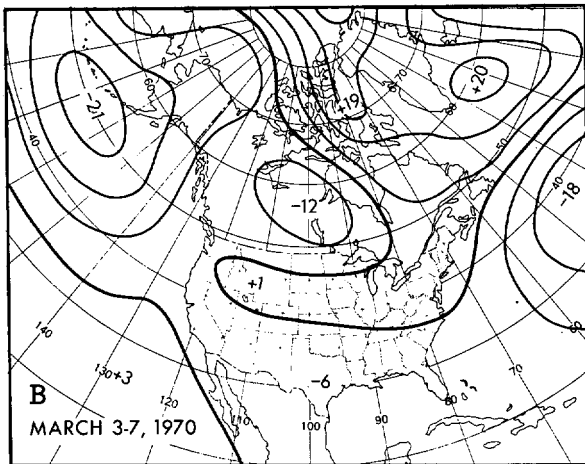
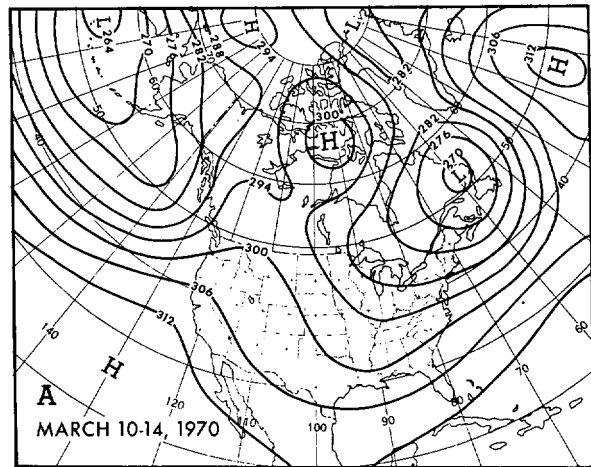
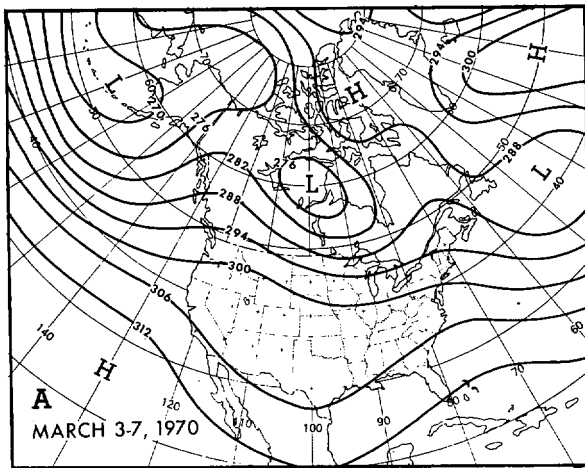
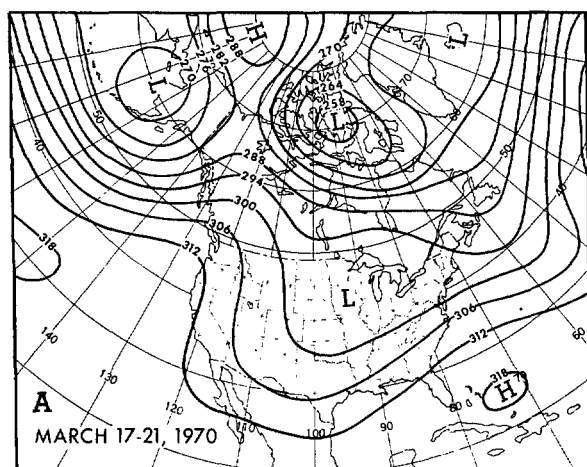


FIGURE 7.—(A) mean 700-mb contours and (B) departure from normal (both in decameters) for Mar. 3-7, 1970; (C) departure of average surface temperature from normal (°F) and (D) total precipitation (inches) for week of Mar. 2-8, 1970 (from Environmental Data Service 1970).

FIGURE 8.—Same as figure 7, (A) and (B) for Mar. 10-14, 1970; (C) and (D) for Mar. 9-15, 1970 (from Environmental Data Service 1970).



Heavy snow was reported from the northern and central Rockies to the Great Lakes early this week and from Arizona to New York shortly thereafter. This was followed by a weekend storm that deposited up to 2 ft of new snow in the Ozarks.

During the week of March 16–22 (fig. 9), a ridge became established from the eastern Pacific across western Canada to the Beaufort Sea, and the circulation over central Canada was more cyclonic. The resulting cold northerly flow in the West ended 9 consecutive weeks of above-normal temperatures at a number of cities. Average temperatures were below normal over most States except along the Canadian border, the Pacific coast, and extreme Southeast. Heavy snow was deposited by two large storms, the first of which followed the southern branch of westerlies well south of normal and produced record snowfall ranging from 30 in. in southeastern Kansas to 14 in. in northwestern Arkansas. The second storm stayed farther north and caused heavy snow from southeastern Montana to south-central Nebraska. Still another storm brought heavy rainfall and thunderstorms across the South and stormy weather over much of the East. In Florida, this was the driest week of March over much of the peninsula with totals of less than an inch. It was also drier than the previous 2 weeks in the Far West where no precipitation fell over most of California, Arizona, and parts of adjoining States.

In the final week of March (fig. 10), the western ridge continued to retrograde and reached its maximum

strength well off the Oregon coast as the downstream trough deepened. Stronger northerly flow in the West brought colder temperatures to the Northern Plains, and nearly all the country was colder than normal. Only the Pacific Coast States and New England reported temperatures higher than normal. This was also a stormy week. One Low lingered over the Great Lakes Region while another developed as it moved into the Central Plains with winds gusting to 80 to 90 mi hr<sup>-1</sup> in Colorado and severe weather with tornadoes in Arkansas and Illinois. Later, storms swung southward west of the Divide bringing 23 in. of new snow at Flagstaff, Ariz., and after crossing the Divide caused heavy rains in parts of the South.

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